REMARKS

Applicants have amended their claims in order to further clarify the definition of various aspects of the present invention. Specifically, Applicants have amended claim 1 to recite an encapsulating "solid" epoxy resin molding material, to recite that the component (C) thereof is a silica, to recite that the silica has a maximum diameter size of at least 32 μm, and to incorporate therein the subject matter of each of the recitations of claim 10. In light of amendments to claim 1, claim 10 has been cancelled without prejudice or disclaimer, and the other claims ultimately dependent on claim 1 have been amended in light of amendments to claim 1. Independent claim 2 has been amended to recite a "solid" epoxy resin molding material, and to recite that the inorganic filler is a silica. Independent claim 3 has been cancelled without prejudice or disclaimer; and independent claim 4 has been amended to recite an encapsulating "solid" epoxy resin molding material, and to recite that this material satisfies "all" of the listed conditions. Claims 5-9 have been amended to be singly-dependent claims, dependent only on claim 1; and claims 5 and 7 have been further amended to recite melt "viscosity" rather than melt density. Claims 11-13 have been amended to be dependent only on claim 1. Claim 15 has been amended to recite that R^2 is selected from an alkyl group having 1-6 "carbon atoms", and claim 16 has been amended to be dependent only on claim 1. Claim 18 has been amended to recite that the R's each represent an alkyl group having 1-4 "carbon atoms". Claims 24 and 25 have been amended to recite heating "loss" ratio. Claims 21, 22, 26, 27 and 32-35 have been cancelled without prejudice or disclaimer. Independent claim 31 has been amended to recite a "solid" epoxy resin molding material.

As for recitation that the encapsulating epoxy resin molding material is "solid", note, for example, the last full paragraph on page 6 of Applicants' specification. With

respect to amendment of claims to recite a melting "viscosity", note the paragraph bridging pages 19 and 20 of Applicants' specification. Clearly, "viscosity" has dimensions of poise.

The objection to the drawings under 37 CFR 1.83(a), set forth in Item 1 on page 2 of the Office Action mailed April 25, 2007, is noted. As recitation of the "air vent" has been cancelled from the claims, it is respectfully submitted that the objection to the drawings is moot.

Applicants respectfully submit that particularly in view of the present amendments to the claims, and the following comments, the rejection of claims under the second paragraph of 35 USC 112, set forth on pages 3-5 of the Office Action mailed April 25, 2007, is moot. Thus, claims 5 and 7 have been amended to recite melt "viscosity", rather than melt density, and claims 15 and 18 have been amended to further define the numerical range in connection with the alkyl groups. In view of these claim amendments, it is respectfully submitted that the bases for rejection of claims 5, 7, 15 and 18 under the second paragraph of 35 USC 112 are moot. In view of cancelling of claims 21, 22, 32 and 33, the bases for rejections of these claims, as set forth in Items 7-9 on pages 3 and 4 of the Office Action mailed April 25, 2007, are moot.

Applicants respectfully traverse the rejection of their claims 24, 25, 28 and 29 as set forth in Items 10-13 on page 4 of the Office Action mailed April 25, 2007, these claims being rejected on the basis that the recitations "heating reduction ratio" and "warp of a semiconductor device" are unclear. In connection with these two recitations, note that Applicants have amended claims 24 and 25 to recite the heating "loss" ratio. In connection therewith, attention is respectfully directed to pages 53 and 54 of Applicants' specification. This portion of Applicants' specification

defines the heating loss ratio Y (note especially the definition of the heating loss ratio, in lines 1-9 on page 54 of Applicants' specification), and also describes a method for controlling the heating loss ratio. Note also disclosure of warping of the material, if the glass transition temperature is less than 150°C. Note also description concerning warping if the bending modulus is more than 19GPa and where the molding shrinkage ratio is greater than 0.2%. As can be appreciated, where the molding material warps, the semiconductor device would warp. Note also disclosure of substrate warp, in Tables 32-35 on pages 120 and 121 of Applicants' specification. It is respectfully submitted that there is a sufficient description as to the meaning of heating loss ratio and as to the meaning of warp of a semiconductor device, in Applicants' specification, such that one of ordinary skill in the art would know whether any specific device fell within or outside the scope of the present claims. It is respectfully submitted that under the present circumstances, the second paragraph of 35 USC 112 requires nothing more. See In re Moore, 169 USPQ 236 (CCPA 1971).

Applicants respectfully submit that all of the claims presented for consideration by the Examiner patentably distinguish over the teachings of the documents applied by the Examiner in rejecting claims in the Office Action mailed April 25, 2007, that is, the teachings of the U.S. patent documents to Osada, et al., Patent No. 6,297,306, to Yamamoto, et al., Patent No. 6,319,619, to Sumita, et al., Patent No. 6,376,923, to Timberlake, et al., Patent Application Publication No. 2003/0148109, and to Ikezawa, et al., Patent Application Publication No. 2003/0201548, under the provisions of 35 USC 102 and 35 USC 103.

It is respectfully submitted that these documents as applied by the Examiner would have neither taught nor would have suggested such an encapsulating solid

epoxy resin molding material as in the present claims, having, inter alia, a silica component, with this silica having a maximum diameter size, average particle size, specific surface area, and also satisfies each of the conditions of amount of particles having a particle size of 12 μm or less, amount of particles having a particle size of 24 μm or less, amount of particles having a particle size of 32 μm or less and amount of particles having a particle size of 48 μm or less, as in claim 1.

Furthermore, it is respectfully submitted that these applied documents would have neither taught nor would have suggested such an encapsulating solid epoxy resin molding material as in the present claims, including, inter alia, the silica component, and wherein this silica includes 5% or more by weight of silica having a maximum particle size of 63 μm or less and particle sizes of 20 μm or more. See claim 2.

Moreover, it is respectfully submitted that these applied documents would have neither taught nor would have suggested such an encapsulating solid epoxy resin molding material as in the present claims, including, inter alia, an inorganic filler, and wherein the molding material satisfies all of the conditions of glass transition temperature, bending modulus and mold shrinkage ratio, as in claim 4.

In addition, it is respectfully submitted that the teachings of the applied documents would have neither disclosed nor would have suggested a semiconductor device encapsulated by an encapsulating solid epoxy resin molding material comprising an epoxy resin, a curing agent and an inorganic filler, as in claim 31.

Furthermore, the teachings of these applied documents would have neither disclosed nor would have suggested such material as in the present claims, having features as discussed previously in connection with the independent claims 1, 2, 4 and 31, and having additional features as in the dependent claims.

The present invention is directed to an encapsulating epoxy resin molding material, and a semiconductor device encapsulated therewith. The encapsulating epoxy resin molding material of the present invention is excellent in filling ability as an under filler for mounting a flip chip device, so as to provide a flip chip package semiconductor device having no molding defects such as voids, and is good in reliability such as reflow resistance and humidity resistance.

As a technique for packaging semiconductor devices which has recently been proposed, in light of higher density packaging of the devices, a flip chip packaging has been used. In flip chip packaging, solder bumps are stuck onto pads of a semiconductor chip, and the bumps are used to connect them to lands on a wiring board. In the thus-packaged device, an under filler is filled into a gap between the chip and the wiring board in order to improve various reliabilities; the under filler is required to have a high filling ability in order to fill the material completely into the narrow gap, where the solder bumps are arranged, without generating cavities such as voids.

Previously, there has been proposed a method of using an encapsulating epoxy resin molding material of a solvent or non-solvent liquid type, penetrating the material into the gap between the chip and the wiring board by use of capillarity, and then curing the material. However, this liquid type encapsulating epoxy resin molding material is expensive, and it is desired to use a solid encapsulating epoxy resin molding material.

However, previously proposed solid encapsulating epoxy resin molding materials have a low filling ability, and, as a result, it is difficult to encapsulate semiconductor elements without generating defects such as voids. Additional

problems which must be overcome by the resin encapsulating material, is avoiding warping of the packaged device.

Against this background, Applicants provide an encapsulating solid epoxy resin molding material which avoids problems of previously proposed materials, which can under fill between the semiconductor chip and mounting board without forming voids, and which avoids warping of the package, among other advantages. Applicants have found that by utilizing an inorganic filler, in particular a silica filler, having a relatively wide particle distribution, as in the present claims, the objectives according to the present invention are achieved.

In this regard, attention is respectfully directed to Tables 2 and 3 on pages 85 and 86 of Applicants' specification. It is respectfully submitted that these tables show a result of influence of particle size distribution of the filler and maximum particle size thereof. By having a distribution as in various of the present claims, generated voids can be avoided, showing advantages achieved according to the present invention. In connection with the results shown in Tables 2 and 3, note from page 79, line 18 through page 83, of Applicants' specification, and the description of particle size distribution and maximum particle size as set forth in Table 1 on page 84 of Applicants' specification.

It is respectfully submitted that this evidence in Applicants' specification must be considered, in determining patentability. See In re DeBlauwe, 222 USPQ 191 (CAFC 1984). It is respectfully submitted that this evidence shows unexpectedly better results achieved according to the present invention, and shows patentability thereof.

Particularly in connection with this evidence, attention is directed to Examples 1-3, 5 and 6, using fillers A, B and C of Table 1 having particle size distributions

within the scope of claim 1, and which show that such fillers were able to produce semiconductor devices without voids. In comparison, the Comparative Examples, with the use of fillers E, F and G not having particle size distributions within the scope of claim 1, caused voids.

Moreover, note that the fluidity of Examples 4 and 7, using a filler D whose maximum particle size did not exceed 32 μm, was inferior to the Examples 1-3, 5 and 6. It is respectfully submitted that it is apparent that Example 4 can not have the fluidity the same as that of Examples 1-3, 5 and 6, without decreasing quantity of filler to be less that of Examples 1-3, 5 and 6. It is respectfully submitted that this evidence shows unexpectedly better results achieved according to the present invention, as in, for example, claims 1 and 2, and supports patentability of the presently claimed subject matter.

Osada, et al. discloses an epoxy resin composition for semiconductor encapsulation, comprising, in admixture, (A) an epoxy resin of a specified formula, (B) a phenolic resin curing agent of a specified formula, (C) molybdenum compound and (D) an inorganic filler. See column 2, lines 56-60. The molybdenum compound is incorporated in order to achieve a sufficient flame retardant effect, and this patent discloses that one effective means for improving dispersibility is to previously support a molybdenum compound on a finely divided inorganic filler carrier. See column 9, lines 30-42. As for the inorganic filler, note column 10, lines 20-64. This patent discloses that no particular limits are imposed on the mean particle size and shape of the inorganic filler; and that spherical fused silica having a mean particle diameter of 1-40 μm, especially 5-20 μm, is preferable from the standpoint of molding and flow. Note especially column 10, lines 30-34. Note column 13, lines 17-19 of this patent, disclosing use of spherical fused silica of a mean particle diameter of 13 μm

as the inorganic filler. This patent also discloses that the molybdenum compound and molybdenum compound-carrying inorganic filler should preferably have a mean particle size of 0.1-20 μm, and a specific surface area of 0.5-50 m^2/g. See column 9, lines 53-58.

Initially, it is respectfully submitted that the portion of column 9 of Osada, et al., referred to by the Examiner, with respect to average particle size and specific surface area of the "inorganic filler", is sizes of the molybdenum compound and molybdenum compound-carrying inorganic filler. It is respectfully submitted that such disclosure in Osada, et al., in connection with molybdenum-containing material which acts as a flame retardant, would have neither disclosed nor would have suggested the presently claimed invention, wherein the inorganic filler has the particle sizes and distribution, and advantages thereof.

In connection with previously considered claim 10, the Examiner refers to disclosures at column 10, lines 31-34 and 62-64 of Osada, et al. It must be emphasized herein that at column 10, lines 30 and 31, it is disclosed that no particular limits are imposed on the mean particle size and shape of the inorganic filler, this patent going on to describe preferable mean particle diameters. Furthermore, Applicants respectfully traverse the conclusion by the Examiner that lines 31-34 of column 10 disclose particle size distributions as in claim 1; again, it is emphasized that column 10, lines 31-34 disclose a preferred range only of 1-40 μm, especially 5-20 μm. It is respectfully submitted that Osada, et al. would have neither taught nor would have suggested the particle range distribution as in the present claims, and advantages thereof.

Moreover, particularly in view of the evidence, in Applicants' specification and discussed previously showing unexpectedly better results achieved by the present

invention, the general disclosure in Osada, et al. would have neither taught nor would have suggested the ranges set forth in the present claims, and advantages thereof.

Furthermore, it is respectfully submitted that Osada, et al. would have neither taught nor would have suggested other features of the present invention as set forth in the dependent claims, dependent on claim 1, and advantages thereof.

The contention by the Examiner in, e.g., Item 27 on page 7 of the Office Action mailed April 25, 2007, that various properties recited in the present claims "would have been inherently satisfied" by the teachings of the applied documents, "because all of the material limitations would have been satisfied", is respectfully traversed. In this regard, it is again emphasized that Osada, et al. requires, inter alia, a molybdenum compound. It is respectfully submitted that the Examiner has not established that the composition of Osada, et al., including the molybdenum compound, would have properties as recited in the present claims. In this regard, it is respectfully submitted that such properties constitute material limitations of the respective claims containing such properties, and must be considered in determining patentability, particularly in view of advantages achieved by the present invention due thereto, as discussed previously.

Yamamoto, et al. discloses a resin composition for semiconductor encapsulating, which contains a thermosetting resin; a hardening agent; and a compound metal hydroxide of polyhedral crystal form represented by a specified general formula. Note the last paragraph in column 2 of this patent. See also column 4, lines 13-17. This patent discloses that the resin composition may also contain an inorganic filler as well as the conventional compound metal hydroxide of thin plate crystal form in addition to the aforementioned components, and that the

inorganic filler is not particularly limited, this patent going on to disclose that the inorganic filler preferably has an average particle diameter ranging from 10 μm to 70 μm, more preferably from 20 μm-50 μm.

It is respectfully submitted that Yamamoto, et al. would have neither taught nor would have suggested such encapsulating solid epoxy resin molding material as in the present claims, having, inter alia, silica filler of the particle size and with distribution as in claim 2, and advantages thereof as discussed previously and as shown in Applicants' disclosure. In this regard, in its disclosure of inorganic filler, Yamamoto, et al. refers to silica powder, having the average particle diameter ranging from 10 μm-70 μm, and it is respectfully submitted that this general range would have neither disclosed nor would have suggested the specifics of claim 2, including the 5% or more by weight of silica having a maximum particle size of 63 μm or less and particle sizes of 20 μm or more, as in claim 2, and advantages thereof.

Sumita, et al. discloses a flip-chip type semiconductor device sealing material and a flip-chip type semiconductor device encapsulated therewith, the sealing material including, inter alia, specific amounts of a liquid epoxy resin, a curing agent, a specified copolymer obtained through addition reaction between an epoxy resin having alkenyl groups and an organopolysiloxane represented by a specified formula, an inorganic filler having a specific surface area of less than 4 m^2/g, and a fine inorganic filler having a specific surface area of at least 4 m^2/g and surface treated with an aminosilane or organosilazane compound represented by a specified formula. Note column 2, lines 21-65. As for the inorganic filler, note column 7, line 59 through column 10, line 12, of this patent. Note especially the paragraph bridging columns 7 and 8 of this patent.

It is respectfully submitted that Sumita, et al. does not disclose, nor would have suggested, the specifics of the silica particles as in claim 1, including particle distribution, maximum diameter size and average particle size, and advantages thereof, or other features of the present invention as in the claims dependent on claim 1.

Moreover, it is emphasized that the present claims, including claims 1 and 31, recite an encapsulating solid epoxy resin molding material. It is respectfully submitted that Sumita, et al., describing a liquid epoxy resin, would have taught away from the presently claimed subject matter, which includes a solid epoxy resin molding material. Again, advantages of the present invention, including reduced costs in comparison with a liquid material, discussed previously, are noted.

Moreover, note that the Examiner has not rejected claim 10 over Sumita, et al. The subject matter of claim 10 has been incorporated into claim 1, claim 1 reciting that each of the conditions of previously considered claim 10 (not just at least one of these conditions) is satisfied. Clearly, claim 1 and claims dependent thereon patentably distinguish over the teachings of Sumita, et al., as applied by the Examiner.

In connection with claim 4 and claims dependent thereon, Timberlake, et al. discloses use of mixtures of hydroxyaryl phosphine oxides and polyhydroxy compounds such as novolak resins as co-curing agents for epoxy resins with enhanced flame retardant properties. See paragraph [0002] on page 1 of this patent publication. As for the blends described in this patent document, effective as epoxy resin hardeners, note paragraph [0019]-[0028] on pages 2 and 3 of this patent document. See also paragraph [0055] on page 5, and [0063] on page 6, of this patent document. This patent document goes on to disclose that fillers may be used

to effect physical properties and reduce costs, typical fillers and reinforcing agents including mica, talc, kaolin, bentonite, wollastonite, glass fiber, glass fabrics, glass mat, milled glass fiber, glass beads, silica or silicon carbide whiskers and so forth. See paragraph [0079] on page 7 of this patent document. Note also the disclosure in paragraph [0106] on page 8 of this patent document, disclosing that the reaction mixture gave a product mixture as an amber colored oil.

It is respectfully submitted that Timberlake, et al. would have neither taught nor would have suggested such an encapsulating solid epoxy resin molding material, satisfying all of the conditions of glass transition temperature, bending modulus and mold shrinkage ratio, as in the present claims, and advantages thereof.

Moreover, Applicants respectfully traverse the conclusion by the Examiner on pages 12 and 13 of the Office Action mailed April 25, 2007, that the specified properties would have been inherent in the teachings of Timberlake, et al. Noting the various components thereof, including the specific mixture which is the curing agent, it is respectfully submitted that the composition disclosed in Timberlake, et al. is not the same as the presently claimed composition, and would not inherently have identical properties, for reasons as discussed previously in connection with Osada, et al.

It is respectfully submitted that the combined teachings of Timberlake, et al. and of Ikezawa, et al., as applied by the Examiner, would have neither disclosed nor would have suggested the presently claimed subject matter of claims 17, 18 as presently in the application, noting that claims 26, 27 and 32-35 have been cancelled without prejudice or disclaimer.

Timberlake, et al. as been previously discussed.

Ikezawa, et al. discloses an epoxy resin molding material for encapsulation, and a semiconductor device encapsulated therein, the encapsulating molding material comprising an epoxy resin, a curing agent, and a silane coupling agent having a secondary amino group or a phosphate, wherein a disk flow is 80 mm or more. Note paragraph [0012] on page 1 of this publication. See also paragraph [0021] on page 2 thereof, which describes that the molding material further comprises an inorganic filler. See also paragraph [0084] on page 6 of this patent publication. As for the inorganic filler, note paragraphs [0103] and [0104] on page 9 of this patent publication.

Even assuming, arguendo, that the teachings of Timberlake, et al. and of Ikezawa, et al. were properly combinable, such combined teachings would have neither disclosed nor would have suggested features of the present invention as in claim 1, in particular the characteristics of the silica including average particle size, maximum diameter size, specific surface area and particle size distribution, as in claim 1.

It is respectfully submitted that the combined teachings of Timberlake, et al. and of Osada, et al. would have neither taught nor would have suggested the subject matter of claim 30.

The teachings of each of Timberlake, et al. and of Osada, et al. have been previously discussed.

Even assuming, arguendo, that the teachings of these references were properly combinable, it is respectfully submitted that the combined teachings would have neither disclosed nor would have suggested the solid epoxy resin molding material which satisfies all of the conditions of glass transition temperature, bending modulus and mold shrinkage ratio, as in claim 4.

In view of the foregoing comments and amendments, reconsideration and allowance of all claims presently in the application are respectfully requested.

To the extent necessary, Applicants petition for an extension of time under 37 CFR 1.136. Authorization is herein given to charge any shortage in the fees, including extension of time fees and excess claim fees, to Deposit Account No. 01-2135 (Case No. 1204.45467X00), and please credit any excess fees to such deposit account.

Respectfully submitted,

ANTONELLI, TERRY, STOUT & KRAUS, LLP

/William I. Solomon/
William I. Solomon
Registration No. 28,565

1300 North Seventeenth Street
Suite 1800
Arlington, VA 22209
Tel.: 703-312-6600
Fax.: 703-312-6666

WIS/slk